IN THE DRAWINGS:

Please withdraw Figure 14 from the application. This figure was included in the original filing, however, no discussion regarding Figure 14 is contained in the specification.

REMARKS

Independent Claims 17 and/or 25 have been rejected by Examiner Lithgow as being anticipated by Smith (U.S. Patent 6,749,757) or by Broussard (U.S. Patent 5,407,584). Reconsideration of the rejection is requested.

Responding to Paragraph 3 of the Office Action and the rejection based upon Smith (U.S. Patent 6,749,757), it is believed that Examiner Lithgow did not correctly compare Smith with the invention. In Smith, the produced water is introduced tangentially with no effort to spread the water "in a horizontal pattern over substantially the full cross section of the vessel." In fact, if Smith attempted to accomplish this distribution, he would necessarily sacrifice his vortex motion because the velocity and force of the water coming into the vessel would necessarily be directed radially and not tangentially. Further, in the present invention water is introduced in a 2-step process, as opposed to a 1-step process in Smith. First, the water is introduced tangentially into a confined cylinder and not into the vessel as a whole as in Smith. Second, the water is then dispersed horizontally without inducing substantive cyclonic motion as is absolutely required by Smith.

Finally, Smith neglects the need to release gas from the arriving produced water which evolves as a result of the pressure of the water being reduced as it is released from upstream separators. The volume of this gas can be substantial (25% or more by volume of the total fluid entering the flotation vessel). The current invention recognizes that some of this gas will gather into large gas bubbles and gas slugs which are disruptive to the flotation process. The current invention utilizes the 2-step process for introducing produced water to remove these disruptive gas bubbles while preserving the small gas bubbles which can be an aid to flotation. Thus Smith

misses a key feature that is required for the practical and successful application of induced gas flotation.

It should further be noted that Smith uses external gas eductors which do not allow one to introduce gas into the flotation vessel in the form of a uniform bubble size distribution that is controlled by the operation of the eductor. In Smith, gas bubbles will coalesce in the piping into the flotation vessel, making their size distribution impossible to predict or control. Thus there is a substantial advantage to the use of the internal radial eductors of the present invention which generate a controllable gas bubble size distribution.

Next, considering Paragraph 4 of the Office Action, Broussard is not anticipatory of the subject matter of the claims in this case. Broussard, as clearly illustrated in Figure 4, injects water to be clarified into a cylindrical device 40 centrally positioned within vessel 10. Water from cylindrical device 40 enters into a larger circumferential upright container vessel 72 and then is discharged upwardly into the interior of vessel 10. Broussard does not teach extracting by cyclonic action large gas bubbles without extracting small gas bubbles and discharging the inlet mixture in a substantially horizontal pattern to disperse the oily water mixture over substantially all of the full cross-sectional area of the vessel. Thus Broussard completely fails to teach the essential steps contained in Claims 17 and 25.

Further, Broussard does not teach the concept of flowing pressurized water through an eductor <u>positioned within a lower portion of the vessel</u>, the eductor having a gas inlet connected to a source of gas and an outlet through which ejected water having small bubbles entrained therein passes and disseminating the ejected water with entrained gas bubbles in a radial substantive horizontal pattern that uniformly disperses the small gas bubbles over substantially a

full cross sectional area on the vessel. For this further reason Broussard does not teach the methods contained in independent Claims 17 and 25 and therefore the rejection over Broussard should be withdrawn.

Superficially, Broussard may appear to anticipate the current invention. However, upon closer inspection, this is not the case as there are features in the present invention that overcome problems with Broussard.

First, the cyclonic inlet in Broussard discharges oil, water and gas upwards above the level of liquid in the flotation vessel. The liquid in this discharge can (and will) land on the surface of the bulk liquid in the vessel causing oily contaminants to redisperse into the produced water. The surface of the liquid will become turbulent as the ejected oil and water lands on the surface, making oil skimming difficult and inefficient. The cyclonic inlet of the present invention overcomes this serious shortcoming by insuring that all liquids are discharged below the surface of the water and that only gas is discharged upwards above the liquid level of the vessel.

Second, the cyclonic inlet device (hydrocyclone 70 in the figures of the Broussard patent) is described by Broussard as "high efficiency". Thus this device will have a tendency to reject all gas bubbles from the incoming liquid and the very critical opportunity to use fine gas bubbles that arrive with the incoming fluid for purposes of flotation is lost. Again, the design of the present invention overcomes this rather serious limitation in Broussard.

Third, the fluid entering the body of the flotation cell after exiting the hydrocyclone through outlet 75 in Broussard has no means for being distributed uniformly over the cross section of the vessel. Contrary to the statements of the Examiner, even Broussard's figures

recognize that water exits the inner cylindrical vessel via annular space 99 in a substantially downward direction and NOT in a horizontal pattern. To efficiently and uniformly contact flotation gas bubbles with oily produced water, both the gas bubbles and the produced water must be uniformly distributed over the cross section of the vessel. If this does not occur, then substantial opportunity exists for the oily water to by-pass the gas bubbles.

The present invention overcomes these serious defects in Broussard by including features that result in substantially uniform distribution of both produced water and the gas bubbles needed for flotation.

Fourth, Broussard claims to distribute gas bubbles substantially uniformly over the cross section of the vessel by using external eductors (see discussion above regarding the undesirable results from the use of external eductors) to introduce flotation gas bubbles. However, the cyclonic action induced the momentum of the eductor water will immediately move these bubbles toward the center of the vessel, thus by-passing water that is moving downward near the flotation vessel's outer walls. Thus, once again Broussard does not accomplish what he claims in that flotation gas bubbles are directed by G-forces developed from the cyclonic action into the center of the vessel, leaving the outer cross sectional area of the vessel devoid of flotation gas.

The present invention overcomes this limitation in Broussard as well by the use of internal eductors and the avoidance of strong cyclonic motion in the flotation vessel that would cause gas bubbles to by-pass oily contaminants in the produced water.

Given the above discussion, we would argue that Broussard should not be cited as prior art regarding the present invention and that the features of the present invention rectify several serious deficiencies in the structure described by Broussard.

Next, addressing Paragraph 5 of the Office Action in which claims have been rejected based upon Gibbs (U.S. Patent 2,695,710), Gibbs is like Broussard in that Gibbs does not teach the significant steps of Claim 25. Gibbs does not teach flowing a gaseous oily water mixture tangentially into an upright tubular cyclonic inlet member. So, irrespective of many other differences, Gibbs does not anticipate the present invention under 35 USC 102(b).

The inlet device taught by Gibbs is a 1-step inlet that at least claims to distribute water flow "radially over the cross section of the vessel." However, this inlet has no means for eliminating the free gas that inevitably enters a flotation vessel in service for the cleaning of produced water. Thus the inlet of Gibbs, while incorporating one feature of the inlet taught by the current invention, is not suitable for use in any service where there is a free gas phase entering the flotation vessel along with the contaminated water. In Gibbs, this free gas would be disruptive to the development and skimming of a surface layer of oil and/or oily solid contaminants.

The current invention overcomes this rather serious difficulty by using a 2-step inlet. First, cyclonic action is invoked to eliminate large and disruptive gas bubbles from the incoming stream. Second, the remaining, now substantially single phase fluid is distributed horizontally and uniformly over the cross section of the flotation vessel.

The inlet design and distribution of the incoming fluid in the present invention are quite novel over Gibbs and resolve serious problems with the Gibbs inlet should it be used in a service where the incoming liquid contains substantial amounts of excess dissolved gas that will be released as a result of pressure reduction from upstream vessels. Furthermore, while Gibbs relies

on the use of a riser pipe for the practice of his invention, this limitation is avoided by using the cyclonic inlet design of the present invention.

Turning now to Paragraph 6 of the Office Action, Claims 25, 28 and 33-35 have been rejected under 35 USC 102(b) as being anticipated by Brown (U.S. Patent 2,730,190). Brown is even less relevant to the subject matter of Claim 25, as Claim 25 has been amended, than either Broussard or Gibbs. Brown shows a vessel having a number of downwardly depending partitions. How can Brown be said to teach the step of flowing an oily water mixture tangentially into an upright vessel positioned concentrically within an upper portion of a larger vessel whereby entrained large gas bubbles but not small gas bubbles are extracted from the mixture and defecting the oily water mixture in a horizontal pattern over substantially the full cross sectional area of the upper portion of the vessel? The downwardly depending partitions prevent this from happening.

Counter current flow water and gas bubble flow is not novel and is not claimed as novel in the current invention. While Brown does use a 2-step inlet design (gas trap and then a distributor), the design of Brown is large and cumbersome compared to the 2-step inlet design of the present invention. Thus the cyclonic inlet and subsequent radial distribution of the contaminated water within the flotation vessel in the present invention is a substantial improvement in the art taught by Brown.

In addition, the gas bubbles introduced by Brown for flotation are either very small (0.1 to 10.0 microns) or very large (500 to 5000 microns). The very small gas bubbles are largely ineffective for flotation in the configuration taught by Brown because their rise velocity is very slow. To overcome this, the flotation vessel used would need to be very large and allow for a

very long fluid residence time (e.g., >10 to 30 min.). The present invention obviates this requirement by introducing gas bubbles for flotation in the range of 100 to 500 microns – substantially less than the size of the "large" gas bubbles taught by Brown. So called "sweep efficiency" calculations clearly show that when using bubbles as large as Brown, a very large volume of gas is required for effective flotation. Again, this is circumvented by the novel features of the present invention.

In summary, the current invention is clearly patentable over Brown as it allows substantial reductions in the size of the flotation vessel and a dramatically smaller, less complex, less expensive inlet design. The citing of counter current gas and water flow by the Examiner is, in my opinion, not relevant and not claimed as novel in the present invention.

Now turning to Paragraph 8 of the Office Action, Claim 23 has been rejected under 35 USC 103(a) based upon the combination of Broussard and GB 2,263,694. First, GB 2,263,694 does not teach distributing water "radially and horizontally". This patent concerns itself with "dissolved air flotation" which is substantially different from "induced gas flotation" which is the subject of the current invention. Figure 5 is intended by the inventor of GB 2,263,694 to be representational only and not descriptive of a specific inlet configuration. In fact the inventor refers to the use of multiple inlet nozzles to effect good distribution of contaminated water in a rectangular tank. Given the above discussion, the only relevance that GB 2,263,694 has to the present invention is the use of counter current water and gas bubble flow –constitutes one step in the flotation process taught in the current invention.

In Broussard there is no driving force left to effect the "radial and horizontal" distribution of water coming out of the annular space 99. If one applied an additional mechanical constraint

to this water, then substantially all of it would exit the top of the inlet cyclone and totally disrupt oil skimming. The configuration taught by Broussard does not lend itself to radial and horizontal distribution of inlet water in a flotation vessel.

Examiner Lithgow is correct in stating that "it is clearly desirable to achieve a uniform up-flow of bubbles to achieve a maximum contacting effect". However, the configuration taught by Broussard does not meet this goal.

In summary, given the irrelevance of GB 2,263,694, the lack of reference in this patent to "radially and horizontally" distributing inlet water, along with the intolerance of the Broussard configuration for the application of "radially and horizontally" distributed water, Applicant respectfully requests this rejection be rescinded.

In Paragraph 9 of the Office Action, Claim 27 is rejected based upon the combination of Broussard, Woeflin (U.S. Patent 2,047,989), and Ettelt (U.S. Patent 3,932,282). Claim 27 has been canceled. Thus no comment needs to be made concerning this rejection.

In Paragraph 10 of the Office Action, Claim 31 has been rejected based upon Broussard in view of Hubred ((U.S. Patent 5,814,228). Reasons why Broussard does not teach the present invention are set forth hereinabove. Thus to say that it is obvious to operate Broussard under the flow velocities recommended by Hubred is not relevant to the patentability of the current invention. In fact, Hubred teaches only the self evident message that in vertical column flotation, the upward rise velocity of gas bubbles must exceed the downward velocity of the water to be cleaned. However, to effectively reduce this self-evident knowledge to practice, one must carefully match the bubble size distribution to the selected downward velocity of the contaminated water. This is the essence of Claim 31. Since the eductor employed in the

embodiment of the current invention generates bubbles with an average size of 150 to 200 microns, it becomes essential to limit the downward water velocity to < 2 ft/min.

In Paragraph 11 of the Office Action, Claim 33 is rejected based upon Broussard, Cairo (U.S. Patent 5,080,802) and Meekel (U.S. Patent 5,584,995). It is well known in the art of flotation separation that smaller gas bubbles are more effective than large gas bubbles. However, a lower limit is defined for vertical column flotation by the need for gas bubbles to rise against the downward counter current flow of water to be cleaned. The bubble size of 100 to 500 microns is the most effective compromise, providing the highest bubble sweep efficiency while maintaining a reasonable net upward rise velocity for the bubbles. In Cairo, a gas/water ratio of 30 to 35% is recommended. However, for the present invention, a gas/water ratio as low as 3% is required (see claim 34). This is somewhat surprising and non-intuitive as it is also well known in the art that increasing the number of gas bubbles will increase flotation efficiency. The present invention is a clear improvement over Cairo. Further, claim 33 of the present invention is not independent, it must be considered in combination with claim 25 and as such, with claim 25 as a preamble, should be considered as novel and a clear improvement over the prior art.

Finally, in Paragraph 12 of the Office Action, Examiner Lithgow rejected Claims 34 and 35 based upon Broussard, Brown (U.S. Patent 2,730,190), and Johnson (U.S. Patent 2,730,240). Claims 34 and 35 are not independent. They must be considered along with the full range of unique and novel features enumerated in Claim 25 as amended. Thus although the gas flow rates given in claims 34 and 35 of the present invention are similar to those stated by Brown and Johnson, the features of the present invention that incorporate these gas flow rates remain unique and very different from the art taught by either Brown or Johnson.

Furthermore, the art taught by Brown and Johnson incorporates bubble size ranges that are outside of the range of bubbles sizes that are useful for the present invention. Thus the fact that similar gas rates are involved in Brown or Johnson is not obvious that one could transfer the recommended volume of gas from Brown or Johnson to the art of the current invention.

The main independent claim of the case, that is Claim 17, has been rejected only as being anticipated by Broussard. It seems irrefutable that Broussard does not teach the sequence of the steps as set out in Claim 17 and as above indicated, the rejection of Claim 17 and the claims which depend from it over Broussard is untenable.

The amendments to the specification and drawings of the application have been made herein to conform with the requirements of Examiner Lithgow. It is deemed that the amendments herein place the application in condition for a Notice of Allowance which is respectfully requested.

Should any other amendments be necessary to place the application in condition for a Notice of Allowance, Examiner Lithgow is invited to call the undersigned at the below noted telephone number.

Respectfully submitted,

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